different imager row and column then the second element, wherein the second pixel element is used to sense light intensity of the first color;

generating a fourth analog signal based on the second analog signal and the third analog signal; and

generating an analog interpolation signal, the analog interpolation signal used to recreate a color value in real-time for a location situated between the first and second pixel elements based on the first analog signal and the fourth analog signal.

40. (As originally filed) The method as defined in Claim 39, further comprising generating an image based on at least the first analog signal, the second analog signal, and the analog interpolation signal.

41. (Amended) The method as defined in Claim 39, further comprising:

reading a fourth pixel element located in a line of pixel elements;

skipping a fifth pixel element located in the line of pixel elements; and

reading a sixth pixel element located in the line of pixel elements.

42. (As originally filed) The method as defined in Claim 39, further comprising performing a windowing operation by reading only a subset of pixel elements during a read operation of the imager.

REMARKS

In the May 18, 2001 Office Action, the Examiner rejected Claims 1-28 under 35 U.S.C. § 112, second paragraph, as being indefinite. In addition, the Examiner rejected Claims 1, 3, 6, 7, 9, 10, 13-16, 18, 22, 25, 27-29, 31, 32, 34, and 36 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,329,312 to Boisvert et al. (hereinafter "Boisvert"). Claim 38 was rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,774,565 to Freeman. Claims 39-41 under 35 U.S.C. § 102(b) as being anticipated by Yatsuyama et al, JP10-10-108209 (hereinafter "Yatsuyama"). The Examiner rejected Claims 2 and 30 under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of U.S. Patent No. 4,805,023 to Younse et al. In addition, the Examiner rejected Claims 4, 5, 21, and 33 under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of U.S. Patent No. 4,245,241 to Sato et al. (hereinafter "Sato"). Claims 8, 17, and 19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Boisvert. In addition, the Examiner rejected Claims 11 and 12 under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of Zhou et al. (hereinafter "Zhou"). The Examiner rejected

Claim 20 under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of Sano et al. (hereinafter "Sano"). In addition, the Examiner rejected Claims 24 and 37 under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of U.S. Patent No. 5,541,654 to Roberts (hereinafter "Roberts"). The Examiner rejected Claims 23 and 35 under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of Yatsuyama. In addition, the Examiner rejected Claims 26 under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of U.S. Patent No. 5,640,202 to Kondo (hereinafter "Kondo"). The Examiner rejected Claim 42 under 35 U.S.C. § 103(a) as being unpatentable over Yatsuyama in view of Roberts.

Attached is a version of the amended pending claims with markings to show changes made by the current amendment, entitled **VERSION WITH MARKINGS TO SHOW CHANGES MADE**, which follows the signature page of this Amendment. In the attachment, the insertions are underlined while the [deletions are placed in brackets].

Discussion of the rejection of Claims 1-28 under 35 U.S.C. § 112, second paragraph

In the May 18, 2001 Office Action, the Examiner rejected Claims 1-28 under 35 U.S.C. § 112, second paragraph, as being indefinite. The Examiner stated that the limitations of "the readout circuit" in line 8 of Claim 1 lacks antecedent basis. Claim 1 has been amended to recite "the readout control circuit," to thereby overcome the rejection. Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claims 1-28 under 35 U.S.C. § 112, second paragraph.

Discussion of the rejection of Claims under 35 U.S.C. § 102(b) as being anticipated by Boisvert

With respect to Claim 1, the Examiner stated that Boisvert discloses a color imaging system providing on-the-fly color interpolation using analog signals to reconstruct color during sensor readout. However, Boisvert fails to teach or suggest, by way of example, an apparatus configured to reconstruct color components for at least a first pixel sensor element and a second pixel sensor element using color information from other pixels elements, and further fails to teach or suggest an apparatus configured to simultaneously read out values for a group of pixel elements within a first portion of the array, including at least two pixel elements from two different rows, further fails to teach or suggest that:

> *the readout control circuit and the array controller are configured to simultaneously read out values for a group of pixel elements within a first*

portion of the array, including at least two pixel elements from two different rows and two pixel elements from two different columns and to reconstruct color components for at least a first pixel sensor element and a second pixel sensor element using color information from other pixels elements within at least the first portion of the array while the readout control circuit is reading said first portion of the array.

as recited by amended Claim 1. Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claim 1 under 35 U.S.C. § 102(b).

With respect to the rejection of Claim 3, Boisvert, which is directed to DC level control circuitry for CCD imaging units (col. 4, lines 38-52), fails to teach or suggest that a "readout control circuit is adapted to perform color interpolation using two pixel sensor elements read out in parallel," as recited by amended Claim 3. Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claim 3 under 35 U.S.C. § 102(b).

With respect to the rejection of Claim 6, the Examiner argues that Boisvert discloses "that the readout control circuit is programmable to read a first pixel element in a first mode and to read second pixel element in a second mode (See Column 1, Line 57; NTSC; where the first mode is for odd pixels and the second mode is for even pixels)." Applicant respectfully traverses the Examiner's characterization of Boisvert. Boisvert fails to teach or suggest a readout circuit that is programmable to perform in two operating modes as claimed. Indeed, a careful review of Boisvert fails to disclose reading even pixels in a first mode and odd pixels in a second mode as argued by the Examiner. Because Boisvert fails to disclose a readout circuit that is programmable to perform in two operating modes, Boisvert fails to teach or suggest that a user controls an operating mode. Thus, Boisvert fails to teach or suggest "readout control circuit is programmable to read a first set of pixel elements in a first user controlled mode of operating the imaging system and to read a second set of pixel elements in a second user controlled mode of operating the imaging system," as recited by amended Claim 6. Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claim 6 under 35 U.S.C. § 102(b).

With respect to the rejection of Claim 9, Boisvert, which fails to teach or suggest a summing circuit, fails to teach or suggest "a first programmable gain amplifier adapted to amplify a first color readout signal a first amount; a second programmable gain amplifier adapted to amplify a second color readout signal a second amount; and a summing circuit coupled to the first programmable gain amplifier and the second programmable gain amplifier," as recited by

amended Claim 9. Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claim 9 under 35 U.S.C. § 102(b).

With respect to the rejection of Claim 13, Boisvert fails to teach or suggest that "programmable gain amplifiers have different transfer functions, including different corresponding exponent values," as recited by amended Claim 13. Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claim 13 under 35 U.S.C. § 102(b).

With respect to Claim 14, the Examiner argues that Boisvert discloses "that at least a portion of the pixel sensor elements are active (Column 6, lines 30-38)." Applicant respectfully traverses the Examiner's characterization of Boisvert. Boisvert only teaches using CCD imagers. Thus, for example, Boisvert does not teach or suggest using CMOS imagers. Therefore, Boisvert fails to teach or suggest that "at least a portion of the pixel sensor elements are active," as recited by Claim 14. Indeed, the portion of Boisvert cited by the Examiner merely states that:

> *By way of example here, a first color-component of an image signal is outputted from the CCD unit 12 on a signal lead 26 as a signal "V in" to an input of the ASP 14A. Similarly, a separate second color-component is applied from the CCD unit 12 on a signal lead 27 to an input of the ASP 14B, and a separate third color-component is applied on a signal lead 28 to an input of the ASP 14C.*

and does not teach or suggest that the CCD unit 12 utilizes active pixel elements as claimed. Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claim 14 under 35 U.S.C. § 102(b).

With respect to Claim 25, the Examiner argues that Boisvert discloses "a television coupled to the readout control circuit (Column 1, Line 20)." Applicant respectfully traverses the Examiner's characterization of Boisvert. Boisvert, at column 1, lines 16-20, merely states in the "Field of the Invention" section of the patent that "This invention relates to a high performance, cost effective electronic analog signal processor for imaging systems utilizing charge coupled devices (CCD's) or the like to provide high quality electronic images for use in high definition color television (HDTV) systems." Boisvert fails to teach or suggest "a television coupled to said readout control circuit," as recited in Claim 25. Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claim 25 under 35 U.S.C. § 102(b).

With respect to Claim 29, the Examiner asserts that Boisvert discloses a method of interpolating color components of array of pixel elements. Applicant respectfully traverses the

Examiner's characterization of Boisvert. A careful reading of Boisvert fails to disclose a teaching or suggestion to perform any method of interpolation, much less:

> *A method of interpolating color components of an array of pixel sensor elements, said method comprising:*
> *reading a first rectangular portion of an array of pixel sensor elements simultaneously, wherein the first rectangular portion includes pixel sensor elements from at least two array columns and two array rows;*
> *reading a second rectangular portion of the array of pixel sensor elements, wherein the second portion partly overlaps said first portion; and*
> *reconstructing color components using interpolation for at least a third portion of the array while said third portion of the array is being read.*

as recited by amended Claim 29. Instead, Boisvert is directed to an analog signal processor that provides DC level control circuitry for CCD imagers (Column 4, lines 1-52). Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claim 29 under 35 U.S.C. § 102(b).

Similarly, with respect to Claims 31 and 32, because Boisvert neither teaches nor suggests performing interpolation all at, Boisvert fails to teach or suggest that "reconstructing color components using interpolation is performed in real-time," as recited by amended Claim 31. Boisvert further fails to teach or suggest that "reconstructing color components using interpolation is performed in an analog domain," as recited by amended Claim 32. Applicant therefore respectfully requests the Examiner to withdraw the rejections to Claims 31 and 32 under 35 U.S.C. § 102(b).

With respect to Claim 36, Boisvert, which fails to teach or suggest "summing a plurality of pixel sensor value readouts associated with a corresponding plurality of pixel sensor elements associated with a first color to produce a first color component," further fails to teach or suggest "summing a plurality of values associated with a plurality of pixel sensor elements associated with a second color to produce a second color component," as recited by amended Claim 36. Instead, Boisvert, at column 8, lines 35-37, merely discloses that the '"dark" level of the output signal of the amplifier 100 at the output terminal 108 is set by a voltage "V offset" at a terminal 114. This voltage "V offset" is applied via a lead 116 at a suitable point in the circuit (not explicitly shown here).' Because Boisvert fails to teach or suggest the claimed invention, Applicant respectfully requests the Examiner to withdraw the rejection to Claim 36 under 35 U.S.C. § 102(b).

Discussion of the rejection of Claim 38 under 35 U.S.C. § 102(b) as being anticipated by Freeman

With respect to Claim 38, the Examiner stated that "Freeman discloses a color imager comprising a first light sensor, a second light sensor, and an interpolation circuit configured to receive a first and second output signal and provide on-the-fly interpolation based on the first and second output signals (Column 5, Lines 9-15)." Applicant respectfully traverses the rejection. Freeman, teaches that "there is derived from an image sensor 10, typically a CCD, a signal in serial form in which successive samples represent the values of charge collected at successive pixels of the sensor" (Column 4, lines 51-54)." Thus, Freeman, which teaches that data is read serially, teaches away from the invention as claimed by amended Claim 38, which recites:

> *a first light sensor which generates a first analog output signal related to the amount of a first color of light sensed;*
> *a second light sensor which generates a second analog output signal related to the amount of said first color of light sensed;*
> *a third light sensor which generates a third analog output signal related to the amount of a second color of light sensed;*
> *a fourth light sensor which generates a fourth analog output signal related to the amount of a third color of light sensed;*
> *a circuit configured to read out the first, second, third and fourth analog values at the same time; and*
> *an interpolation circuit configured to receive at least said first output signal and said second output signal, wherein said interpolation circuit provides an interpolation signal on the fly based on at least said first analog output signal and said second analog output signal.*

Because Freeman fails to teach or suggest the claimed invention, Applicant respectfully requests the Examiner to withdraw the rejection to Claim 38 under 35 U.S.C. § 102(b).

Discussion of the rejection of Claims 39-41 under 35 U.S.C. § 102(b) as being anticipated by Yatsuyama

With respect to Claim 39, the Examiner argues that "Yatsuyama et al. disclose a method of interpolating a color value in the analog domain in real time comprising receiving first and second analog signals corresponding to the outputs of first and second pixels that are separated from each other and sense light intensity of a first color, and generating an analog interpolation signal used to create a color value for a location between the first and second pixel elements based on the first and second analog signals (See Figure 6 and SOLUTION)." However, because Yatsuyama, as cited by the Examiner, does not teach or suggest the claimed invention, Applicant

respectfully traverses the Examiner's rejection of Claim 39. For example, the SOLUTION and Figure 6 fail to disclose that interpolation is performed in real time. Further, the SOLUTION and Figure 6 of Yatsuyama fail to disclose in what domain interpolation is performed, and therefore further fail to disclose by way of example, "generating an analog interpolation signal" as claimed. Instead, the SOLUTION and Figure 6 of Yatsuyama merely discloses mathematical and other functions used to perform interpolation. For example, the SOLUTION states that when "an upper/lower subtractor section 7 and a left/right subtractor 8 are used to obtain a difference between upper/lower color signal quantities and a difference between left/right color signal quantities, a comparator 9 is used to compare the relation in large or small quantity of the differences, and the color signal system discriminated to be smaller is selected by using a switch section 10 ..."

Thus, Yatsuyama does not teach or suggest:

> *receiving a first analog signal corresponding to the output of a first pixel element in an imager, the first pixel element used to sense light intensity of a first color;*
> *receiving a second analog signal corresponding to the output of a second pixel element in the imager, the second element spaced from the first pixel element, wherein the second pixel element is used to sense light intensity of the first color;*
> *receiving a third analog signal corresponding to the output of a third pixel element in the imager at the same time as the first and second analog signal, the third element in a different imager row and column then the second element, wherein the second pixel element is used to sense light intensity of the first color;*
> *generating a fourth analog signal based on the second analog signal and the third analog signal; and*
> *generating an analog interpolation signal, the analog interpolation signal used to recreate a color value in real-time for a location situated between the first and second pixel elements based on the first analog signal and the fourth analog signal.*

as recited by amended Claim 39. Applicant therefore respectfully requests the Examiner to withdraw the rejection to Claim 39 under 35 U.S.C. § 102(b).

Similarly, with respect to Claim 40, because the SOLUTION and Figure 6 of Yatsuyama fail to disclose in what domain interpolation is performed, the SOLUTION and Figure 6 therefore fail to teach or suggest "generating an image based on at least the first analog signal, the second analog signal, and the analog interpolation signal," as recited by Claim 40. Applicant therefore respectfully requests the Examiner to withdraw the rejection to Claim 40 under 35 U.S.C. § 102(b).

With respect to Claim 41, the Examiner argues that Yatsuyama discloses reading "a third pixel located in a line of pixels, skip a fourth pixel element in the line, and read a fifth pixel element located in the line of pixel elements (See Figure 6)." Applicant respectfully traverses the Examiner's characterization of Figure 6 of Yatsuyama. Figure 6 merely shows a grid of what are apparently green pixels. Figure 6 does not disclose how pixels are read and therefore does not teach or suggest the order in which pixels are read or whether pixels are skipped in a reading process. Figure 6 therefore fails to teach or suggest reading a "fourth pixel element located in a line of pixel elements; skipping a fifth pixel element located in the line of pixel elements; and reading a sixth pixel element located in the line of pixel elements," as recited by amended Claim 41. Applicant therefore respectfully requests the Examiner to withdraw the rejection to Claim 41 under 35 U.S.C. § 102(b).

Discussion of the Rejection of Claims under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of Sato

In rejecting Claim 4, the Examiner admitted that Boisvert fails to disclose the recited analog storage units. Nonetheless, the Examiner argues that Sato discloses "such an arrangement for a color image sensor (Column 1, Lines 61-65; Column 3, Lines 9-36), a process by which resolution is enhanced (Column 1, lines 65-67; Column 3, Lines 34-36)." The Examiner further argues that "it would have been obvious to one of ordinary skill in the art at the time of the invention to configure the Boisvert et al. device to have the filter design of Sato et al. and to employ the recited first and second analog line storage in order to enhance the resolution of the device." Applicant respectfully traverses the Examiner's characterization of Sato. Sato, as cited by the Examiner, states that

> *In accordance with the structural arrangement of this invention, a (R+G+B) signal is always obtained by adding optical signals from the two photosensors adjacent each other in the vertical direction, that is, outputs of two horizontal lines adjacent each other. Thus, the resolutions of the brilliance component and the hue component can be enhanced. Among the four adjacent photosensors, the two corresponding filter elements are the complementary color filters, so that the light utilization factor is enhanced.* (Column 1, Lines 61-67)

and

> *In FIG. 2(b), the B and G filters and their complementary color filters are selected. In FIG. 2(c), the G and R filters and their complementary color filters are selected. The Cy signal=(B+G) signal, the Mg signal=(R+B) signal, and the Ye signal=(R+G) signal. In the case of FIG. 2(a), therefore, the R signal and the*

(R+G) signal are obtained from the n-th horizontal line, and the (G+B) signal and the B signal from the (n+1)-th horizontal line. As shown in FIG. 3, accordingly, an output of the imaging device is separated into the respective signals of the n-th and (n+1)-th horizontal lines by the use of a one horizontal scanning period-delay circuit 1 and a signal switching circuit 2. As a result, the R signal and the (R+G) signal are provided at an output 2a of the signal switching circuit 2, and the (G+B) signal and the B signal are provided at an output 2b thereof. The output signals 2a and 2b are synchronously detected by synchronous detector circuits 3 and 4 and then passed through low-pass filters (LPF) 7 and 8, respectively, whereby the R signal and the B signal of base bands can be obtained.

On the other hand, when the signals of the n-th row and (n+1)-th row are added by an adder circuit 5, the sum signal of two photosensors adjacent in the vertical direction becomes an (R+G+B) signal at all times. By employing this signal as a luminance signal, a picture of good resolution can be reproduced. Column 3, Lines 9-36.

Thus, Sato appears to merely to disclose the summing of signals of adjacent photosensors, and the filtering of the summed signals. However, a careful reading of Sato fails to disclose or suggest:

a first analog line storage unit, the first analog line storage unit being adapted to store a first line readout from the array; and

a second analog line storage unit, the second analog line storage unit being adapted to store a third line readout from the array, wherein the readout control circuit averages a second consecutive line readout from the array with the first line readout stored in the first analog line storage unit to produce a first red-green-blue (RGB) triplet, the readout control circuit averaging a fourth consecutive line readout from the array with the third line readout stored in the second analog line storage unit to produce a second RGB triplet.

as recited by Claim 4. Thus, neither Boisvert nor Sato, or a combination thereof, teach or suggest the claimed invention. Applicant therefore respectfully requests the Examiner to withdraw the rejection to Claim 4 under 35 U.S.C. § 103(a).

With respect to Claim 21, neither Boisvert or Sato, or a combination thereof, teach or suggest that a "readout control circuit and the array controller read out a first set of pixel sensor elements and then readout a second set of pixel sensor elements, such that the second set of pixel sensor elements only partly overlaps a portion of the first set of pixel sensor elements," as recited by amended Claim 21. Instead, Sato discloses that one or more horizontal lines are read sequentially (Column 3, line 61, to Column 4, line 9). Applicant therefore respectfully requests the Examiner to withdraw the rejection to Claim 21 under 35 U.S.C. § 103(a).

Discussion of the Rejection of Claims under 35 U.S.C. § 103(a) as being unpatentable over Boisvert

With respect to Claim 8, the Examiner admits that Boisvert is silent regarding the manufacturing process used for pixel sensor elements. Nonetheless, the Examiner argues that Boisvert discloses that sensor elements are not limited to a particular CCD element. Applicant traverses the Examiner's rejection. Boisvert only discloses the use of CCD imagers and CCD elements. CCD imagers are not conventionally manufactured using a CMOS manufacturing processes. Even when contemplating the use of alternatives to the disclosed sensors, Boisvert only discusses using CCD imagers. "For example, the imaging systems are not limited to a particular CCD unit". Thus, Boisvert implies that while the disclosed imaging systems are not limited to a *particular* CCD unit, they are apparently limited to some type of CCD unit. Indeed, Boisvert, not only fails to teach that pixel sensor elements form a portion of a complementary metal oxide semiconductor device as claimed, Boisvert teaches that "it is difficult to implement the ASP in complementary metal oxide semiconductor (CMOS) technology because of the limited high frequency response of CMOS devices." Thus, Boisvert, in only disclosing the use of CCD imaging systems and in teaching away from the use of CMOS devices in the disclosed analog signal processors, fails to teach or suggest the claimed invention. A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984); M.P.E.P. § 2141.02. Thus, for at least these reasons, Applicant therefore respectfully requests the Examiner to withdraw the rejection to Claim 8 under 35 U.S.C. § 103(a).

Discussion of the Rejection of Claims under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of Zhou

With respect to Claims 11 and 12, the Examiners admitted that Boisvert fails to disclose programmable amplifiers being contained with the pixel circuit of the array and within a plurality of column buffers. Nonetheless, the Examiner states that such a design for amplifiers used with an image sensor is well know in the art as disclosed in Zhou and "clearly would reduce the size of the Boisvert et al. device. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to configure Boisvert et al. device so as to have its programmable amplifiers contained within the pixel circuitry of the array within a plurality of column buffers in

order to reduce the size of the device." Applicant respectfully traverses the rejection of Claims 11 and 12.

A careful reading of Zhou fails to disclose the claimed programmable amplifiers, and therefore fails to teach or suggest that "programmable gain amplifiers are contained within a pixel circuitry of the array," as recited by Claim 11. Similarly, Zhou fails to teach or suggest that "the programmable gain amplifiers are within a plurality of column buffers," as recited by Clam 12. Thus, neither Boisvert nor Zhou, or a combination thereof, teach or suggest the claimed invention. Applicant therefore respectfully requests the Examiner to withdraw the rejection to Claims 11 and 12 under 35 U.S.C. § 103(a).

Discussion of the Rejection of Claims under 35 U.S.C. § 103(a) as being unpatentable over Boisvert in view of Yatsuyama

With respect to Claims 23 and 35, the Examiner admits that Boisvert fails to disclose the readout control circuit and the array controller processing a first set of pixel sensor elements, skipping a second set of pixel sensor elements and processing a third set of pixel sensor elements. Nonetheless, the Examiner argues "that such an operation for a color image sensor is well known in the art as a means for more efficiently providing missing color information for a given pixel, as disclosed in Yatsuyama et al. (See Figure 6 and SOLUTION)." The Examiner further argues that is would have been obvious to one of ordinary skill in the art at the time of the invention to configure the Boisvert et al. device so that is readout control circuit and array controller processes a first set of pixel sensor elements, skips a second set of pixel sensor elements and processes a third set of pixel sensor elements in order to more efficiently provide missing color information." Applicant respectfully traverses the Examiner's rejection.

As previously discussed with respect to Claim 41, Figure 6 of Yatsuyama merely shows a grid of what are apparently green pixels. Figure 6 does not disclose how pixels are processed and therefore does not teach or suggest the claimed invention. Further, the SOLUTION section Yatsuyama also fails to disclose the order of pixel processing and therefore does not teach or suggest processing a first set of pixel sensor elements, skipping a second set of pixel sensor elements and processing a third set of pixel sensor elements. In addition, the "Examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." Ex parte Clapp, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985). The Examiner has failed to provide any support

for the assertion that missing color information would be more efficiently provided by configuring the Boisvert et al. device so that is readout control circuit and array controller processes a first set of pixel sensor elements, skips a second set of pixel sensor elements and processes a third set of pixel sensor elements. Thus, the Examiner has failed to present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of Boisvert in view of Yatsuyama. Thus, for at least these reasons, Applicant therefore respectfully requests the Examiner to withdraw the rejection to Claims 23 and 45 under 35 U.S.C. § 103(a).

Summary

In view of the foregoing amendment and remarks, Applicant respectfully submits that independent amended Claims 1, 29, 38, 39 are patentably distinct over the cited art and are in condition for allowance. Claims 2-28, 30-37, and 40-42 which correspondingly depend for independent Claims 1, 29, and 39 and further define Claims 1, 29, and 39, are likewise patentably distinct over the cited art and are in condition for allowance. Applicants respectfully request allowance of Claims 1-42.

If there are any issues that can be resolved by telephone, the Examiner is respectfully requested to call the undersigned attorney of record at (310) 407-3461 or at the number set forth below.

Respectfully submitted,

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VERSION OF CLAIMS WITH MARKINGS TO SHOW CHANGES MADE

Claims 1, 3, 6, 9, 13, 16, 21, 29, 31-36, 38-39, and 41 have been amended as follows.

1. (Amended) A color imaging system providing on-the-fly color interpolation using analog signals to reconstruct colors during sensor readout, the imaging system comprising:

an array of pixel sensor elements wherein at least part of the array is arranged in rows and columns;

a color filter including a plurality of color filter components organized in a predefined pattern, the color filter overlaying at least a portion of the array;

a readout control circuit coupled to the array; and

an array controller coupled to the array;

wherein the readout control circuit and the array controller are configured to simultaneously read out values for a group of pixel elements within a first portion of the array, including at least two pixel elements from two different rows and two pixel elements from two different columns and to reconstruct color components for at least a first pixel sensor element and a second pixel sensor element using color information from other pixels elements within at least [a] the first portion of the array while the readout control circuit is reading [at least] said first portion of the array.

3. (Amended) The system of Claim 1, wherein the readout control circuit is adapted to [read a plurality of] perform color interpolation using two pixel sensor elements read out in parallel.

6. (Amended) The system of Claim 1, wherein the readout control circuit is programmable to read a first set of pixel elements in a first user controlled mode of operating the imaging system and to read a second set of pixel elements in a second user controlled mode of operating the imaging system.

9. (Amended) The system of Claim 1, further comprising;

a first programmable gain amplifier adapted to amplify a first color readout signal a first amount [and]; a second programmable gain amplifier adapted to amplify a second color readout signal a second amount; and

a summing circuit coupled to the first programmable gain amplifier and the second programmable gain amplifier.

13. (Amended) The system of Claim 9, wherein the programmable gain amplifiers have different transfer functions, including different corresponding exponent values.

16. (Amended) The system of Claim 1, wherein at least [a] the first pixel sensor element is associated with a different color filter component than a neighboring pixel sensor element.

21. (Amended) The system of Claim 1, wherein the readout control circuit and the array controller [process] read out a first set of pixel sensor elements and then [process] readout a second set of pixel sensor elements, such that the second set of pixel sensor elements only partly overlaps a portion of the first set of pixel sensor elements.

29. (Amended) A method of interpolating color components of an array of pixel sensor elements, said method comprising:

reading a first rectangular portion of an array of pixel sensor elements simultaneously, wherein the first rectangular portion includes pixel sensor elements from at least two array columns and two array rows;

reading a second rectangular portion of the array of pixel sensor elements, wherein the second portion partly overlaps said first portion; and

reconstructing color components using interpolation for at least a third portion of the array while said third portion of the array is being read.

31. (Amended) The method of Claim 29, wherein reconstructing color components using interpolation is performed in real-time.

32. (Amended) The method of Claim 29, wherein reconstructing color components using interpolation is performed in an analog domain.

33. (Amended) The method of Claim 29, wherein the [act of reading includes reading a first set of pixel sensor elements and then reading a second set of pixel sensor elements, such that the second set of pixel sensor elements overlaps a portion of the first set of pixel sensor elements] overlapped portion is used to interpolate color components in both the first rectangular portion and the second rectangular portion of pixel sensor elements.

34. (Amended) The method of Claim 29, [wherein the act of] further comprising reading [includes reading] a [first set] fourth portion of pixel sensor elements and then reading a [second set] fifth portion of pixel sensor elements, such that the [second set] fourth portion of

pixel sensor elements does not overlap [a portion of the first set] the fifth portion of pixel sensor elements.

35. (Amended) The method of Claim 29, wherein the act of reading includes reading a first set of pixel sensor elements in an array row, skipping a second set of pixel sensor elements in the array row and reading a third set of pixel sensor elements in the array row, the method further comprising:

summing a plurality of pixel sensor value readouts associated with a corresponding plurality of pixel sensor elements associated with a first color to produce a first color component corresponding to a first skipped pixel sensor element; and

summing a plurality of values associated with a plurality of pixel sensor elements associated with a second color to produce a second color component corresponding to a second skipped pixel sensor element.

36. (Amended) The method of Claim 34, further comprising:

summing a plurality of pixel sensor value readouts [values] associated with a corresponding plurality of pixel sensor elements associated with a first color to produce a first color component; and

summing a plurality of values associated with a plurality of pixel sensor elements associated with a second color to produce a second color component.

38. (Amended) A color imager comprising:

a first light sensor which generates a first analog output signal related to the amount of a first color of light sensed;

a second light sensor which generates a second analog output signal related to the amount of said first color of light sensed; [and]

a third light sensor which generates a third analog output signal related to the amount of a second color of light sensed;

a fourth light sensor which generates a fourth analog output signal related to the amount of a third color of light sensed;

a circuit configured to read out the first, second, third and fourth analog values at the same time; and

an interpolation circuit configured to receive said first output signal and said second output signal, wherein said interpolation circuit provides an interpolation signal

on the fly based on at least said first analog output signal and said second analog output signal.

39. (Amended) A method of interpolating a color value in the analog domain in real-time, comprising:

receiving a first analog signal corresponding to the output of a first pixel element in an imager, the first pixel element used to sense light intensity of a first color;

receiving a second analog signal corresponding to the output of a second pixel element in the imager, the second element spaced from the first pixel element, wherein the second pixel element is used to sense light intensity of the first color; [and]

receiving a third analog signal corresponding to the output of a third pixel element in the imager at the same time as the first and second analog signal, the third element in a different imager row and column then the second element, wherein the second pixel element is used to sense light intensity of the first color;

generating a fourth analog signal based on the second analog signal and the third analog signal; and

generating an analog interpolation signal, the analog interpolation signal used to recreate a color value in real-time for a location situated between the first and second pixel elements based on the first analog signal and the [second] fourth analog signal.

41. (Amended) The method as defined in Claim 39, further comprising:

reading a [third] fourth pixel element located in a line of pixel elements;

skipping a [fourth] fifth pixel element located in the line of pixel elements; and reading a [fifth] sixth pixel element located in the line of pixel elements.

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